

## **REMARKS**

No claims have been amended herein.

### **Rejection under 35 USC §103(a)**

Claims 1-29 stand rejected under 35 U.S.C. 103(a) as being unpatentable in view of U.S. Patent No. 5,026,927 (Andrews et al.). Applicants respectfully disagree. The claimed process demonstrates a surprising increased yield and increased selectivity towards glycols. The prior art, which teaches away from the claimed subject matter, does not render the claimed invention obvious.

#### **Summary**

In their prior response, Applicants noted that the Examiner had correctly summarized the teachings of the Andrews et al. reference. In short, the Examiner pointed out that Andrews et al. teaches a process for the hydrogenolysis of a sugar feedstock in a solvent in the presence of a ruthenium/phosphine catalyst and an optional base promoter; that Andrews et al. generally teaches that the solvent can be water and that the hydrogenolysis can be conducted at from 25°C to 200°C (see Col. 3, lines 15-17 and lines 34-40).

Of significance is that Andrews et al. (1) prefers a hydrogenolysis temperature of between 50°C and 150°C (claim 10); and (2) does not exemplify a hydrogenolysis process of the type instantly claimed, i.e., one which is carried out at a temperature greater than 150°C in the presence of water. When these points are properly considered, the non-obviousness of claimed invention becomes abundantly clear. In short, the prior art teaches away from hydrogenolysis temperatures above 150°C, i.e., the temperature range required by the pending claims.

Applicants have previously discussed examples in their specification that provide unexpected results and have identified selectivity improvements resulting from the claimed invention over what is disclosed in the Andrews et al. reference. In particular, the selectivity of the reaction towards glycols in the claimed temperature range (greater than 150°C) is always better than at the lower temperatures exemplified in Andrews et al.

The Claims Are Not Obvious In  
View Of The Prior Art As A Whole

Andrews et al. discloses a very broad group of solvents, stating at column 3, lines 10-18, that

"suitable solvents are polar solvents that dissolve sugars but have low coordinating strengths towards Group VIII metal complexes, typically amides such as N-methyl-2-pyrrolidinone and N,N-dimethylacetamide. Generally, fully alkylated amides are useful as solvents in the invention. Water can also be used if the metal catalyst is made soluble in water, for example by conversion to anion or cation by any known method."

Thus, the prior art as represented by Andrews et al. states that amides are the preferred solvents but in certain circumstances water may be used. It is noted that in all of the examples of Andrews et al. the solvent is N-methyl-2-pyrrolidinone.

With respect to reaction temperatures, the general teaching in Andrews et al. is for a range of from about 25°C to about 200°C, which, as the Examiner will appreciate, is a particularly large range for a chemical reaction. At column 3, line 45, Andrews et al. teaches that the process is preferably carried out at a temperature of from about 50°C to about 150°C, and more preferably from about 75°C to about 125°C. Thus, the general teaching of that patent is towards the lower to middle temperatures of the range given as the general range. It is further noted that in most of the examples the reaction temperature is 100°C.

Kruse (U.S. Patent No. 3,935,284) relates to the homogeneous hydrogenation of monosaccharides, disaccharides, trisaccharides and polysaccharides in the presence of a catalyst comprising a ruthenium triphenylphosphine complex and a strong acid. Thus its teaching is directly relevant to the analysis here. This patent states:

"The reaction temperature employed in the hydrogenation process may be varied over a wide range. However, preferred results are achieved in the range of from about 75°C to about 150°C. However, it has also been found that at temperatures above about 150°C. no further increase in the reaction rate is noted and it is, therefore, not preferred to carry out the reaction at temperatures much above 150°C. Also, at temperatures above about 150°C. the catalyst may not be stable and, due to decarbonylation of the substrate, carbonyl complexes of the ruthenium triphenyl phosphine may occur. These complexes are not efficient catalysts for the hydrogenation reaction."

Kruse, column 5, lines 11-30.

Thus, Kruse clearly teaches that problems start to occur at temperatures above 150°C. One of ordinary skill in the art would expect that if the process of Andrews et al. was operated at above 150°C decarbonylation of the catalyst would occur. Decarbonylation is, of course, not seen in Andrews et al. since all the examples in that patent are conducted at or below 100°C.

Kruse clearly teaches away from the temperature range in the claims because of the problem of decarbonylation, which is a deactivation route for ruthenium catalysts. This problem was well known as of the filing date of the subject application. See, for example, Jung et al. (*Organometallics*, vol. 1, no. 4, 1982, pages 658-666) describes a series of ruthenium-phosphine ketone hydrogenation catalysts that are deactivated in the presence of aldehydes<sup>1</sup> due to the formation of carbonyl species via decarbonylation.

The Examiner's attention is also directed to James et al. (*Inorg. Chimica Acta, Reviews* 1970, pages 73-95) which describes the general deactivation of ruthenium catalysts for hydrogenation of the presence of CO. This article mentions that while some monocarbonyl species appear to be active as ketone hydrogenation catalysts, their activity is at least reduced when multiple carbonyl groups become attached.

Decarbonylation of the substrate was again discussed after the filing of the Andrews et al. patent. See Van de Sluys et al. (*Organometallics*, 10, 1991, 1033)<sup>2</sup> which describes the decarbonylation of alcohols using  $\text{Ru}(\text{H}_2)(\text{PPh}_3)$  at a temperature of only 60°C.

Andrews et al. suggests in column 2, at lines 44-53, that the catalyst may be any homogeneous transition metal aldehyde or ketone hydrogenation catalyst of the Group VIII metals of the Periodic Table. They then go on to give specific examples, all of which are triphenyl phosphine complexes. Two different catalysts are used in the Examples and, significantly, both are used at low temperatures, i.e., below the point where decarbonylation would occur and well below the temperatures required in the instant claims.

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<sup>1</sup> In aqueous solution, sugars, in particular, aldoses, exist as hemi-acetals in equilibria with the aldehyde form.

<sup>2</sup> Copies of the Jung et al, James et al., and Van de Sluys et al. references were provided to the Patent Office in the Information Disclosure Statement filed on October 20, 2008.

The claimed invention is directed to a process which operates at temperatures where the catalyst would normally be carbonylated by the product/feedstock and therefore deactivated. The present inventors have discovered that if water is present and certain temperatures are employed, then deactivation is prevented and improved results are achieved.

In Andrews et al., water is merely mentioned as a possible solvent; there was clearly no appreciation or teaching that the combination of water and temperature would lead to improved results. Indeed, the prior art teaches away from the claimed reaction conditions because temperatures above 150°C are taught to lead to deactivation of the catalyst and, accordingly, diminished results.

As a result, the invention as claimed is clearly not obvious in view of the pertinent prior art. Applicants respectfully request the Examiner to reconsider and withdraw the 35 U.S.C. § 103(a) rejection.

In view of the above amendments and remarks, Applicants respectfully submit that the claims are in condition for allowance. A Notice of Allowance is therefore respectfully solicited.

The Applicants urge the Examiner to contact the Applicants' undersigned representative at (312) 913-2136 if he believes that a discussion would expedite prosecution of this application.

Respectfully submitted,

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By: /Steven J. Sarussi/  
Steven J. Sarussi  
Reg. No. 32,784

McDonnell Boehnen  
Hulbert & Berghoff LLP  
300 South Wacker Drive  
Chicago, Illinois 60606  
(312) 913-0001